

# MODIS Airborne Simulator (MAS) Retrievals of cloud thermodynamic phase, optical thickness, and particle size

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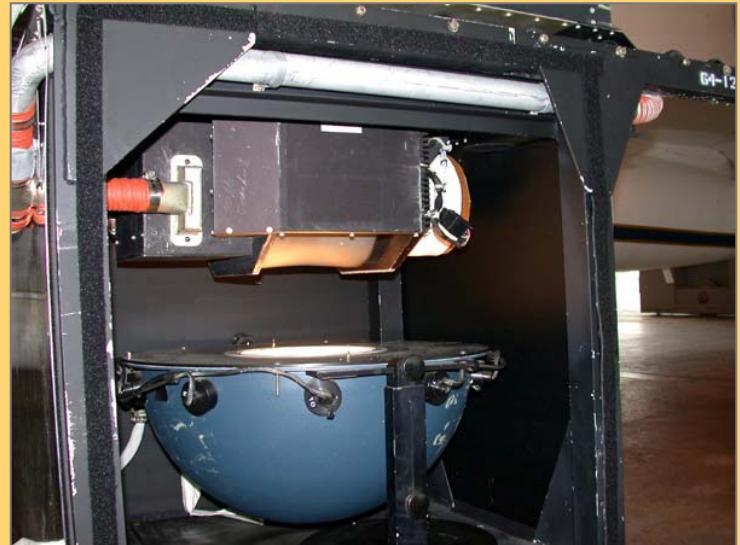
***CRYSTAL-FACE Science Team Meeting***

Salt Lake City UT

26 February 2003

# Outline

- The MODIS Airborne Simulator
  - overview
  - calibration
- Data
  - web site and quicklook imagery, L1B
- Case study examples
- Future efforts



## MAS instrument overview

- Scanning, grating spectrometer with 4 optical ports
  - Operated by NASA Ames Airborne Sensor Facility (*J. Myers, M. Fitzgerald*)
  - 50 spectral bands (v. 36 MODIS bands) including:  
0.65, 0.86, 0.94, 1.61, **1.64**, **1.88**, 2.1, 3.7, 11  $\mu\text{m}$  ***bold=MAS only***
  - 50 m spatial resolution (at ground, nominal ER-2 altitude),  $\pm 43^\circ$  scan
- Calibration
  - Ames Calibration lab (*P. Hajek*)
  - Radiometric
    - Thermal bands: on-board blackbody
    - Solar reflective bands: pre/post-deployment laboratory calibration, field ground-based measurements for trend monitoring
  - Spectral
    - Pre/post-deployment laboratory calibration

# MAS instrument cloud algorithms

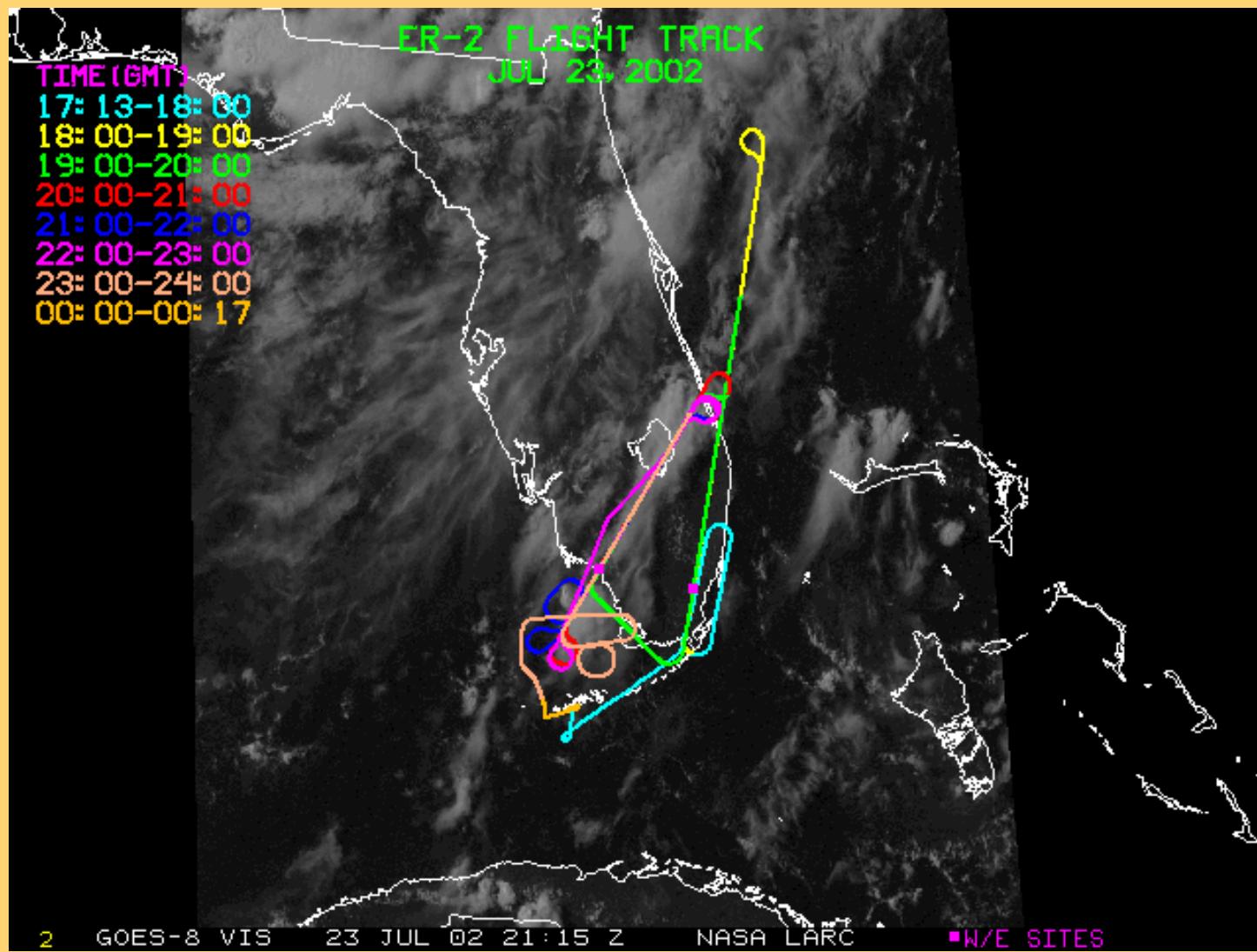
## MODIS heritage algorithms

- Cloud mask: *U. Wisconsin (S. Ackerman, et al.)*
- Cloud optical & microphysical properties (optical thickness, effective particle size ( $\sim \langle V \rangle / \langle A_{cs} \rangle$ ), water path, thermodynamic phase): *NASA GSFC (King, Platnick, et al.)*
  - Primary particle size retrieval from 2.1  $\mu\text{m}$  band
  - Optical thickness information from 0.65  $\mu\text{m}$  (land), 0.86  $\mu\text{m}$  (ocean)
  - Thermodynamic phase derived from combination of cloud mask tests, IR bispectral (B. Baum), and SWIR bands (J. Riedi)
  - Ice cloud radiative transfer libraries: 12 distributions, combination of 4 habits as a function of size - (*P. Yang, A. Heymsfield, et al.*)
  - Surface albedo derived from MODIS albedo & ecosystem products (*Boston U., Strahler, Schaff, et al.*)

# MAS information, data

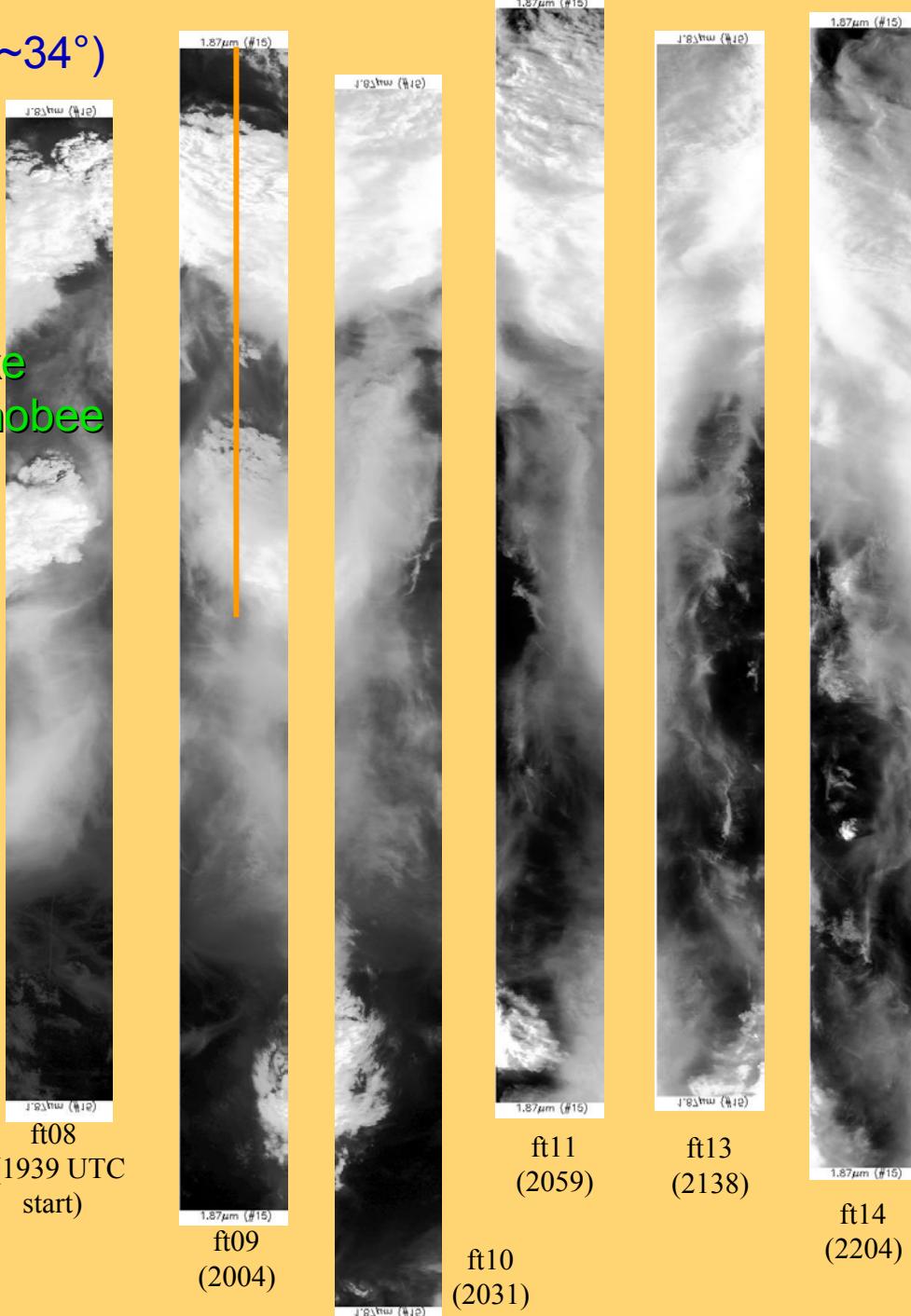
- Web site:
  - MAS quicklook, ER-2 mission summaries, flight tracks, etc.  
[http://mas.arc.nasa.gov/data/deploy\\_html/crystalfacehome.html](http://mas.arc.nasa.gov/data/deploy_html/crystalfacehome.html)
- Data
  - L1B data (calibrated, geolocated) archived in HDF(4), by ER-2 straight line flight track: <http://daac.gsfc.nasa.gov/fieldexp/MAS/>
  - L2 products (cloud mask, thermodynamic phase, optical thickness/particle size retrievals) available on request
  - Requested case studies processed to date, selected flight tracks:
    - 23, 29 July** (L. Li, G. Heymsfield, McGill, Starr) - developing convection over peninsula
    - 26 July** (A. Heymsfield) - southern sortie
    - 13 July** (Jensen) - thin cirrus
    - 16, 23 July** (Mace) - western gnd. site observations
    - 9, 11, 29 July** (Di Girolamo) - Terra/MISR

# 23 July case study ER-2 flight tracks



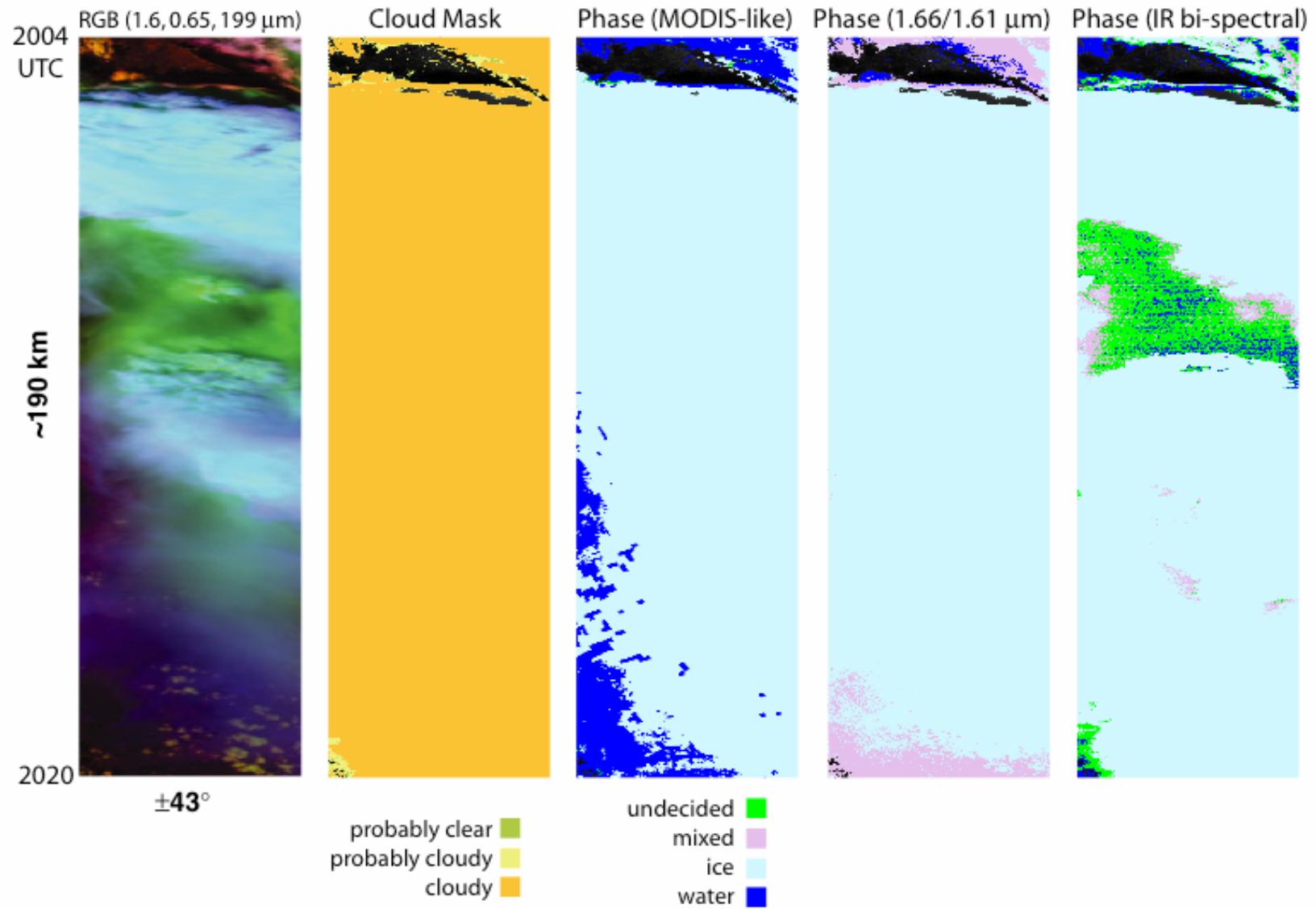
NNE (~34°)

Lake  
Okeechobee

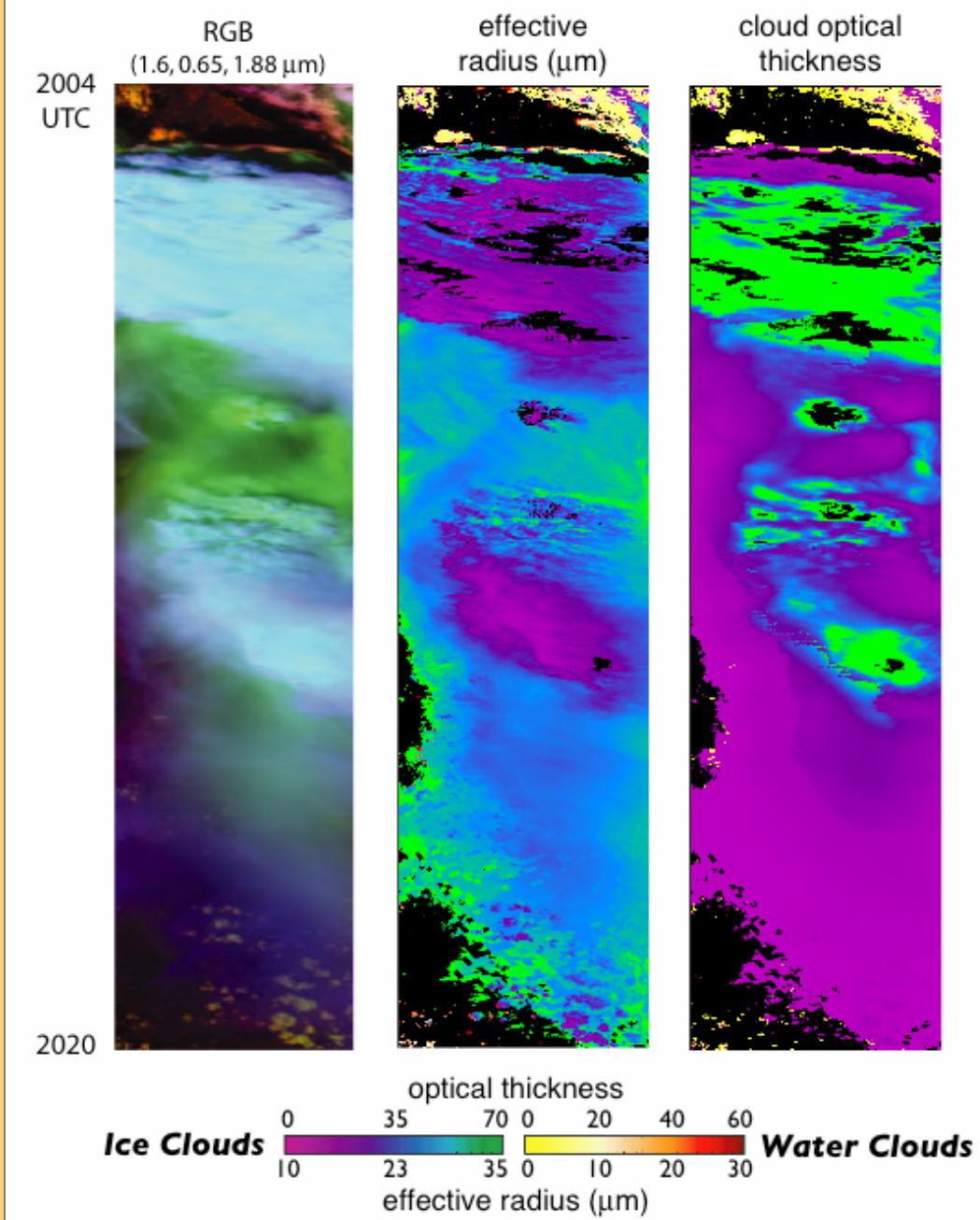


MAS 1.88  $\mu\text{m}$  band  
23 July 2002  
(from MAS web site)

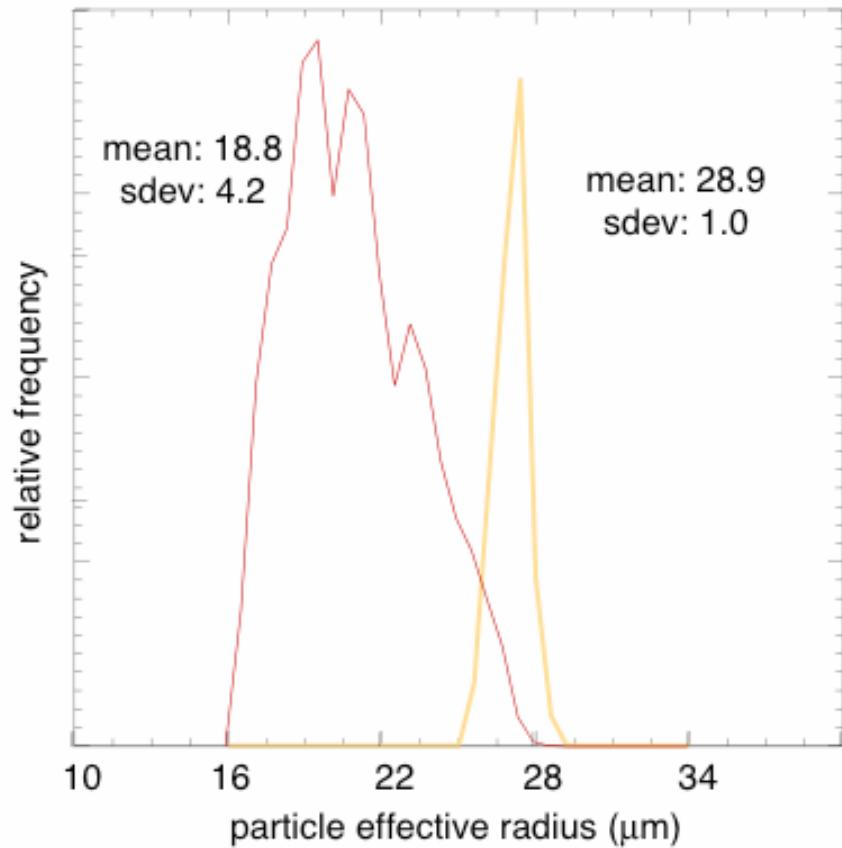
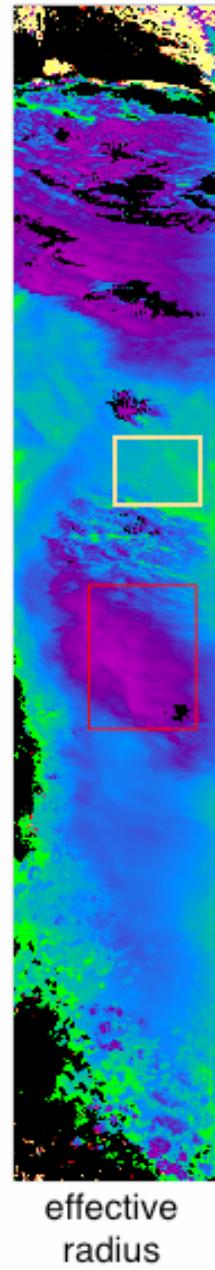
## MODIS Airborne Simulator, 23 July 2002, Flight#09-953, Track#9 Three Phase Method Comparison



MAS 23 July, FI09

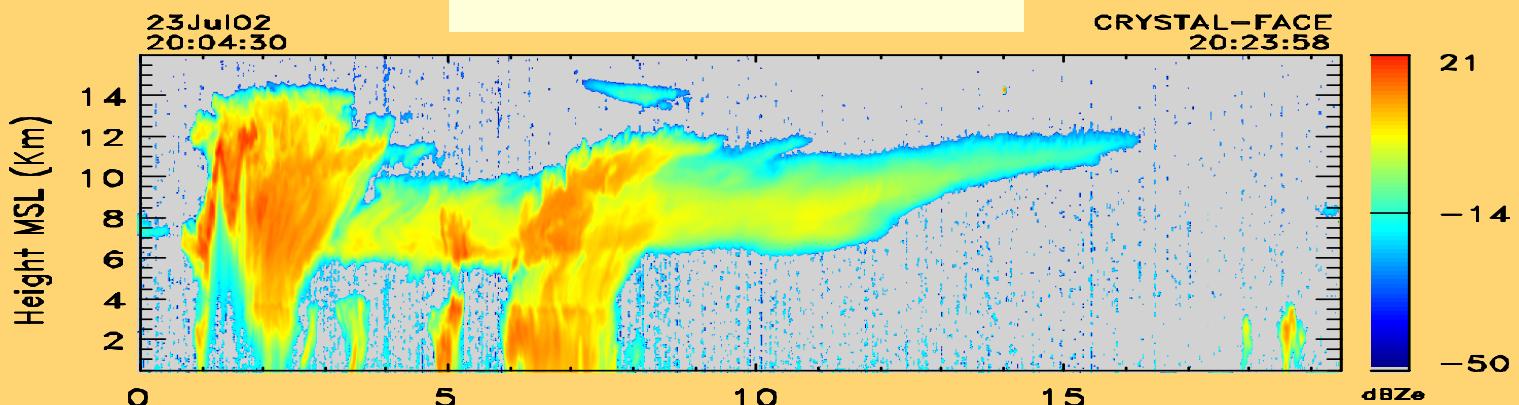


MAS 23 July, Fl09

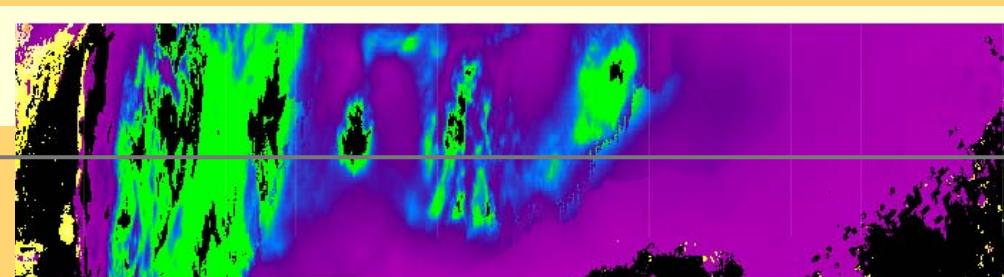


Selected histograms  
- particle size

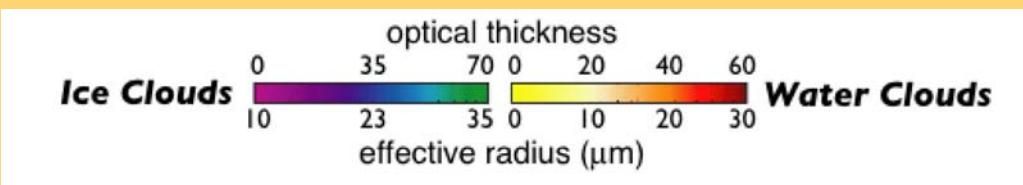
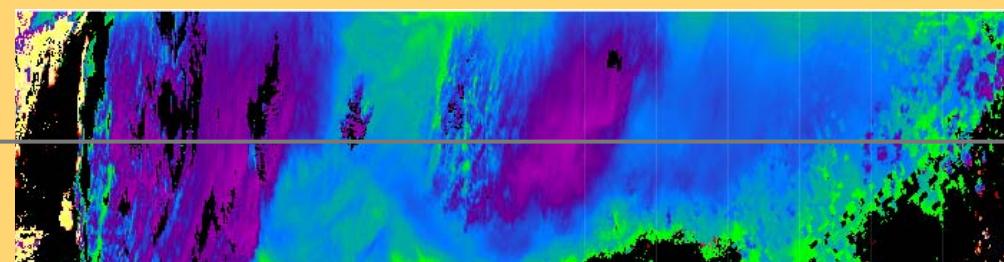
## CRS nadir radar reflectivity (*Heymsfield, Li*)



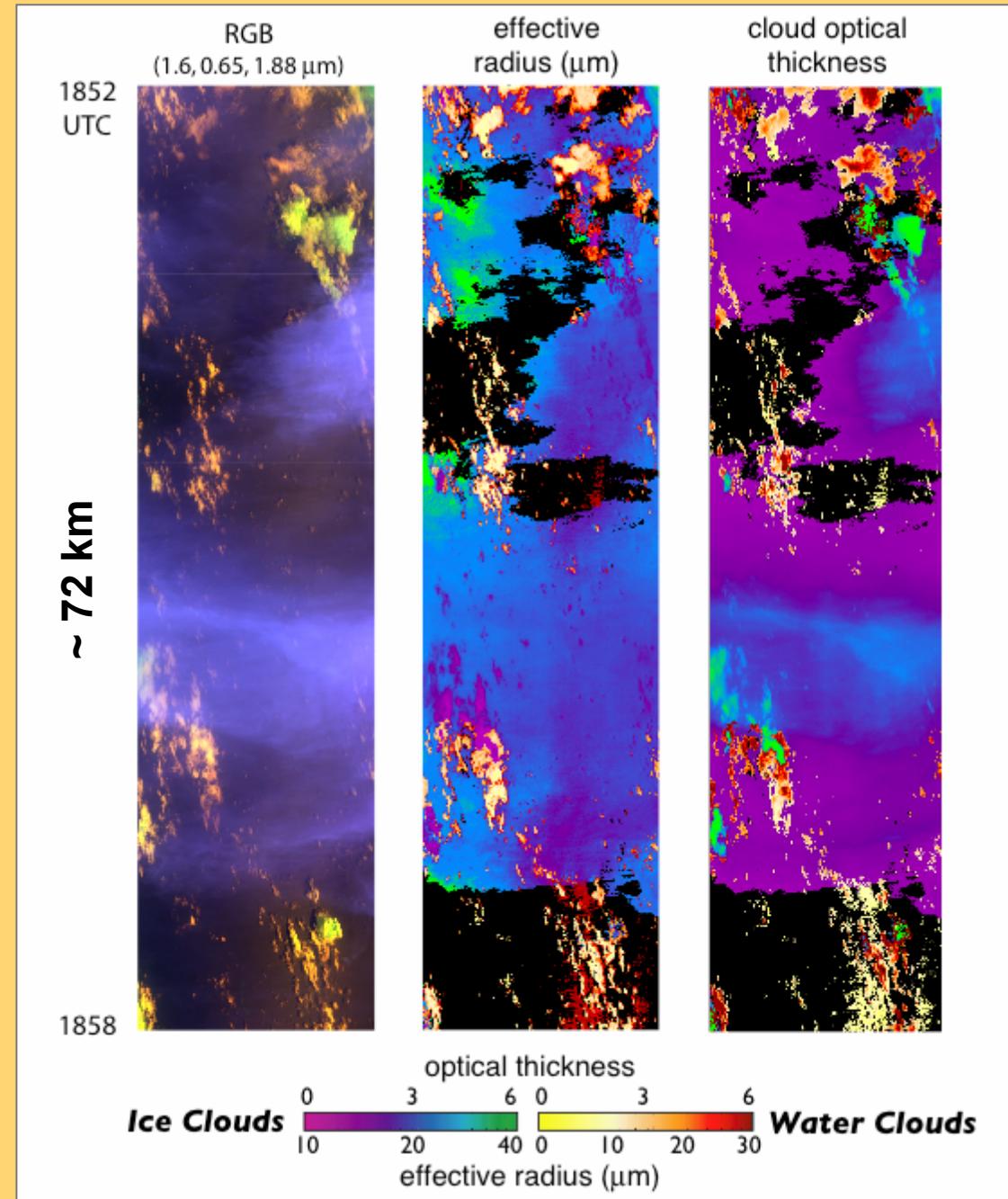
MAS optical thickness



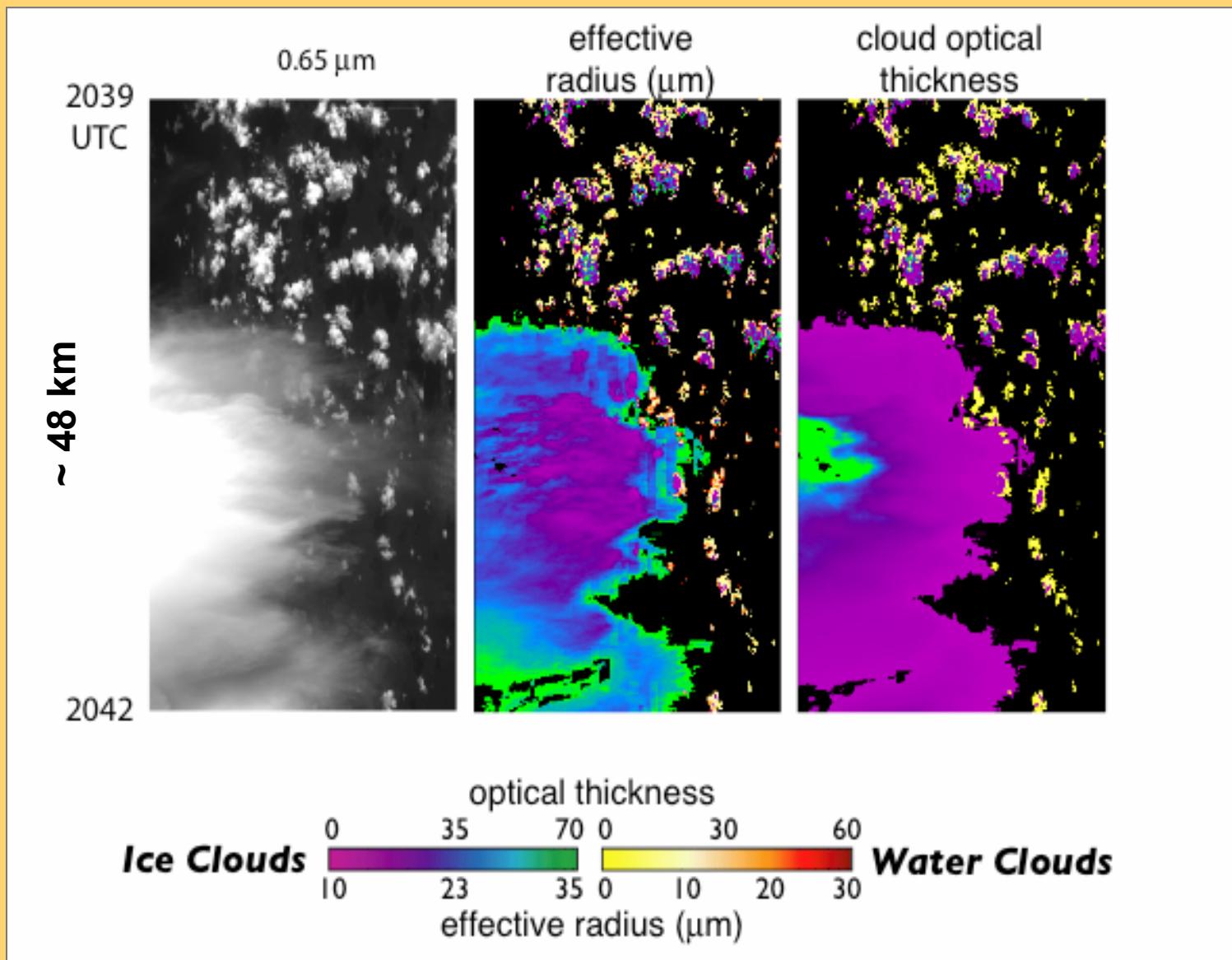
MAS effective radius ( $\mu\text{m}$ )



MAS  
26 July, FI07  
southern sortie  
(coordination w/WB-57)



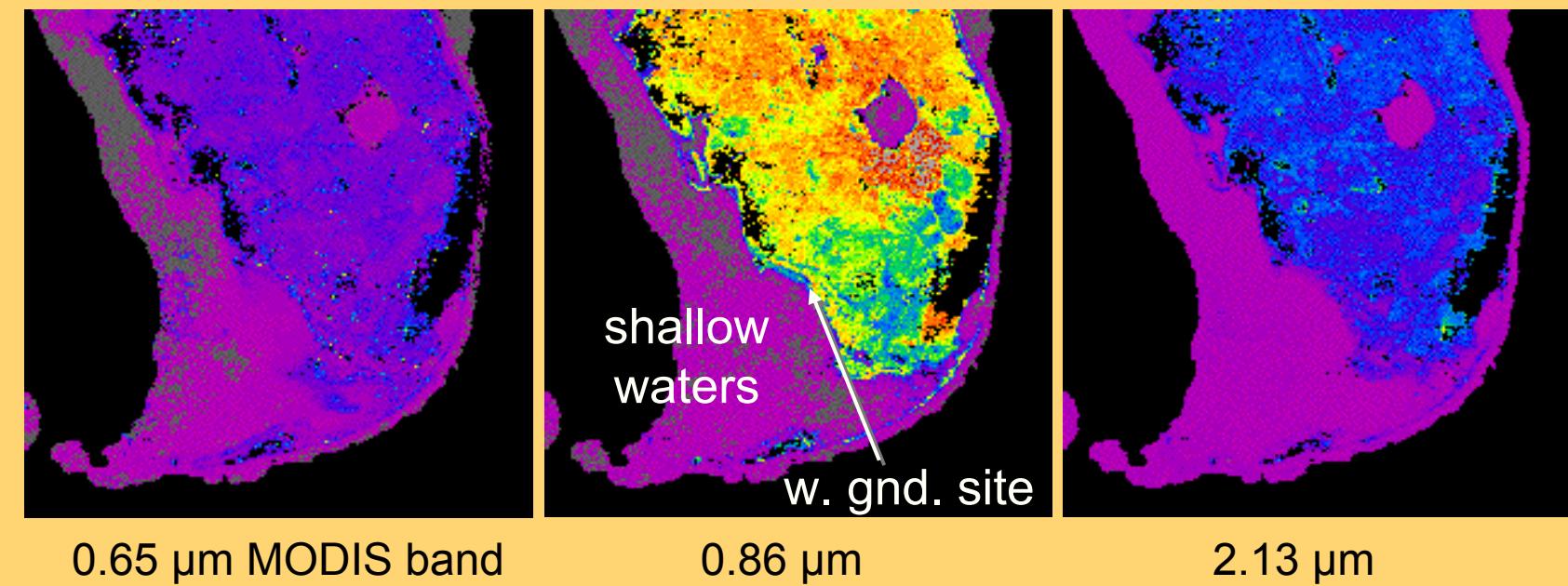
# MAS, 16 July, FI08, western gnd. site coordination



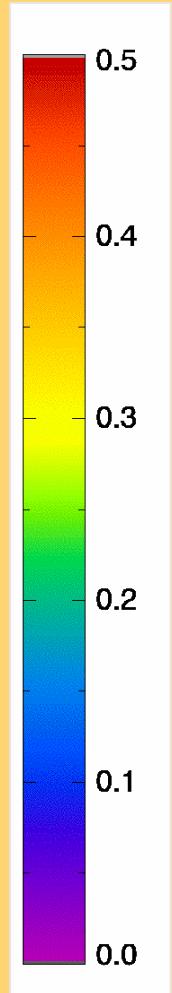
## MAS - future activities

- Optical/microphysical retrieval issues
  - thin cirrus limitations: sun glint, surface reflectance
  - ice scattering radiative transfer libraries
  - comparison with other instruments/techniques, including:
    - Remote: IR techniques (MAS/MODIS/AIRS); Radar/lidar (CRS, EDOP, CPL): water path, particle size, extinction; AirPOLDER, RSP: phase, directional properties
    - In situ: CIN, size distributions, et al.
- Science - why do these retrievals matter?
  - Scaling up to satellite retrievals
  - Broad range of small scale cloud microphysical issues (water path, size, etc.), modeling
  - Linkage w/radiative flux ( $g$ )

Southern FL spectral surface albedo from MODIS  
(derived from product MOD43, ~1.7 km resolution,  
diffuse sky, 8/2001)



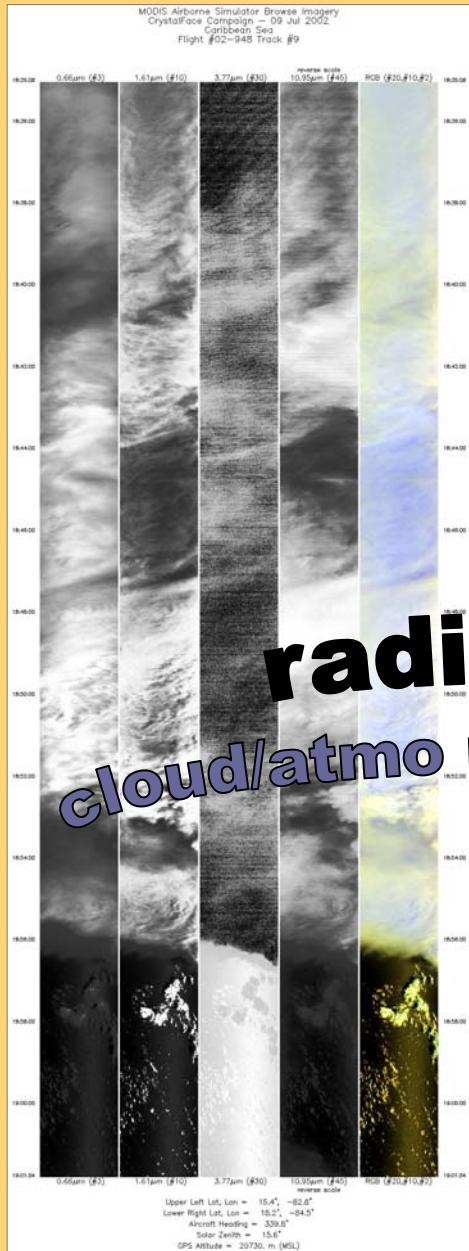
*vis reflectance* →  
for  $\tau_c=0.5 \sim 0.03$



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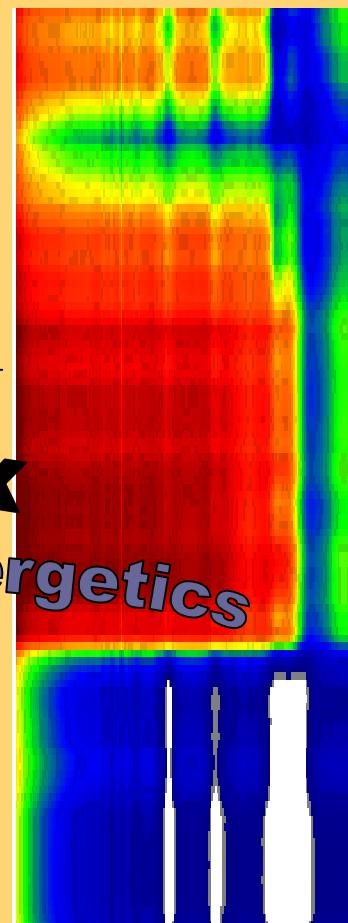
# MAS & ER-2 SSFR (Pilewskie): 9 July 2002



1835 UTC

350 nm

1700 nm



**radiance → flux**  
*cloud/atmo properties → energetics*

1901 UTC

Albedo

